may be obtained by applying to Mr. Lydekker, at The Lodge, Harpenden, Herts.

Monday and Tuesday, August 29 and 30.—The museum of the Royal College of Surgeons will be open to members of the Congress on production of their ticket. An official of the museum will be present to receive visitors.

Tuesday, Wednesday and Thursday, August 30 and 31, and September 1.—Dredging expeditions at Plymouth with the Director of the Marine Biological Laboratory, and at Port Erin, Isle of Man, under the direction of Prof. Herdman, F.R.S.

Note.—Visitors to either of these dredging expeditions should give notice to the Secretaries in writing as early as possible.

The gardens of the Zoological Society of London will be open to members of the Congress on showing their tickets and writing their names in the book at the gates every day, including Sunday, from Thursday, August 18, to Thursday, September 1, inclusive.

The Committee of the Royal Societies' Club, St. James's Street, S.W., will extend the privileges of honorary membership to members of the Congress (not ladies) on presentation of their cards of Congress membership, from August 18 to September 1, inclusive. Members of the Congress making use of the Club must enter their names in the visitors' book.

The President and Council of the Linnean Society, Burlington House, Piccadilly, will throw open their apartments to the members of the Congress of Zoology from August 27 to September 1, inclusive.

The gardens of the Royal Zoological Society of Ireland will be open to members of the Congress who visit Dublin on presenting their cards of membership at the gate.

A YORKSHIRE MOOR.[1]

I.

THE Yorkshire moor is high, ill-drained, peaty, and overgrown with heather. Moors of this type abound in Scotland, and creep southward along the hills into Yorkshire and Derbyshire, breaking up into smaller patches as the elevation declines. In the south of England they become rarer, though famous examples occur in Dartmoor and Exmoor. In the north they may cover great stretches of country. It used to be said that a man might walk from Ilkley to Glasgow without ever leaving the heather. That was never quite true, but even to-day it is not far from the truth; a man might walk nearly all the way on unenclosed ground, mostly moorland.

Neither peat nor heather is confined to high ground. Peat often forms at sea-level, and may contain the remains of sea-weed. In some places it is actually submerged by change of sea-level, and the peasants go at low water and dig through the sand to get it. Heather ranges from sea-level to Alpine heights.

Peat may form because there is no fall to carry off the water, or because the soil, though high and sloping, is impermeable to water. A few feet of stiff boulder-clay constitute such an impermeable floor, and a great part of our Yorkshire moors rests upon boulder-clay, which is attributed to ice-action, because it is often packed with ice-scratched pebbles, some of which have travelled far, and because the rock beneath, when bared, exhibits similar scratches.

The rocks beneath the boulder-clay of a Yorkshire moor are chiefly sandstones and shales. Where the sandstones crop out, they form tolerably bold escarpments with many fallen blocks, such as we call "edges" in the north; the shales make gentler slopes. Both the surface-water and the spring-water of the moors are pure and soft; they may be tinged with peat, but they contain hardly any lime, potash, or other mineral substance except iron-oxides.

The wettest parts of the moor are called *mosses* (in some parts of Scotland they are called *flow-mosses*) because the Sphagnum-moss grows there in profusion. The Sphagnum-swamps are an important feature of the moor, if only because they form a great part of the peat. Not all the peat, however; some is entirely composed of heather and heath-like plants, while now and then the hair-moss (Polytrichum) and certain moorland lichens contribute their share, but the Sphagnum-swamps play the leading part, especially in starting new growths of peat. If we walk carelessly over the moor, we now and then step upon a bed of Sphagnum. We have hardly time to notice its pale green tint and the rosy colour of the new growths before all close observation is arrested by the cold trickle of water into the boots. The practised rambler takes care to keep out of the Sphagnum swamps altogether, knowing that he may easily sink to the knees or further. Sphagnum sucks up water like a sponge, and if you gather a handful, you will be surprised to see how much water can be squeezed out of it. This water abounds in microscopic life; Amœbæ and other Rhizopods, Diatoms, Infusoria, Nematoids, Rotifers and the like can be obtained in abundance by squeezing a little Sphagnum fresh from the moors.[1] As the stems of Sphagnum grow upwards, they die at the base, and form a brown mass, which at length turns black, and in which the microscope reveals characteristic structural details, years, perhaps centuries after the tissues ceased to live.

An old Sphagnum moss is sometimes a vast spongy accumulation of peat and water, rising higher in the centre than on the sides, and covered over by a thin living crust. The interior may be half-liquid, and when the crust bursts after heavy rain, the contents of a hillside-swamp now and then pours forth in an inky flood, deluging whole parishes. In 1697 a bog of 40 acres burst at Charleville, near Limerick. In 1745 a bog burst in Lancashire, and speedily covered a space a mile long and half a mile broad. A bog at Crowhill on the moors near Keighley burst in 1824, and coloured the river with a peaty stain as far as to the Humber. In December 1896, a bog of 200 acres burst at Rathmore near Killarney, and the effects were seen ten miles off. Nine persons perished in one cottage.

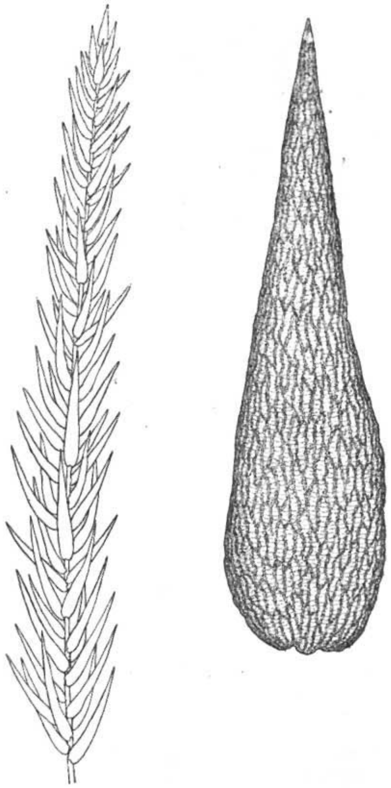

FIG. 1.—Leafy branch of Sphagnum, magnified; one leaf of ditto, further magnified.

The soaking-up of water is essential to the growth of the Sphagnum, which employs several different expedients for this purpose. Its slender stems give off numerous leafy branches, and also branches which are reduced to filaments. These last turn downwards along the stem, which they may almost conceal from view. The crowded leaves have in-folded edges. There are thus formed innumerable narrow chinks, in which water may creep upwards. The microscope brings to light further contrivances, which answer the same purpose. Many of the cells of the leaf lose their living substance, and are transformed into water-holding cavities with thin, transparent walls, which are prevented from collapsing by spirally wound threads. But the water must not only be lodged; it must ascend, and supply the growing branches above. Accordingly the water-holding cells are not closed, but pierced by many circular pores, which allow liquid to pass in and out freely. Perforated water-cells also form the outer layers of the stem. Thus the whole surface of the plant, whether immersed or not, is overspread by a water-film, which is easily replenished from below as it evaporates above. It is the water-spaces which render the Sphagnum so pale. The green living substance forms only a thin network, traversing the water-holding tissue.

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[1] A discourse given at the Royal Institution, February 1898. By L. C. Miall, F.R.S.

[1] It is interesting to note that the same abundance of animal life characterises the mosses of Spitzbergen, where not a few of the very same species are found. (D. J. Scourfield, "Non-marine Fauna of Spitzbergen," *Proc. Zool. Soc.*, 1897.)

Now and then we are lucky enough to see the bed of a Sphagnum-swamp. Quarrying, or a land-slip, or the formation of a new water-course, may expose a clean section. I have known the mere removal of big stones, time after time, from the bed of a stream fed by a Sphagnum-swamp, gradually increase the cutting-power of the running water, until the swamp is not only drained, but cut clean through down to the solid rock. Then we may see that the peat rests upon a sheet of boulder-clay, and this upon the sandstones and shales. Between the peat and the boulder-clay there is sometimes found an ancient seat-earth, in which are embedded the mouldering stumps of long-dead trees. Oak, Scotch fir, birch, larch, hazel, alder, willow, yew and mountain-ash have been met with.[1] Where a great tract of peaty moorland slowly wastes away, the tree-stumps may be found scattered thick over the whole surface. Above the seat-earth and its stumps, if these occur at all, comes the peat, say from 5 to 20 feet deep, and above the peat the thin crust of living heather.

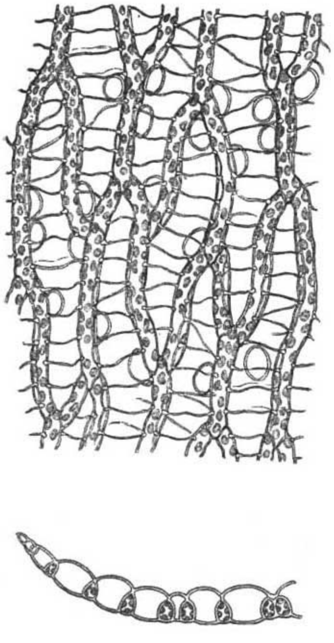

FIG. 2.—Detail of Sphagnum-leaf; green cells with corpuscles, and water-cells with spiral threads and pores. Below is a section (from Sachs) of part of a leaf.

Every part of the moor has not, however, the same kind of floor. Streams in flood may excavate deep channels, and wash out the gravel and sand into deltas, which often occupy many acres, or even several square miles. The outcrops of the sandstones crumble into masses of fallen blocks. Instead of the usual impervious bed of boulder-clay, we may get a light sub-soil. The verges of the moor have commonly this character; they are by comparison dry, well drained, and overgrown with furze, bilberry, crowberry, fern, and wiry grasses; such tracts are called "roughs" or "rakes" in the north of England. A similar vegetation may be found far within the moor, though not in places exposed to the full force of the wind. Even on the verges of the moor there are very few earthworms, and at most a scanty covering of fine mould; in the heart of the moor there is no trace of either. The Nematoid worms which are so common in most soils, and easily brought to the surface by pouring a few drops of milk upon the ground, seem to be absent from the moor. Insects and insect-larvæ are very seldom found in the humus.

In a country where population and industry grow steadily, it is rare to find the moor gaining upon the grass and woodland. We have to go back some centuries to find an example on anything like a large scale. The Earl of Cromarty (*Phil. Trans.* No. 330, p. 296), writing in 1710, says that in 1651 he saw a "firm standing wood" of dead fir-trees on a hill-side in West Ross-shire. About fifteen years later he passed the same spot, and found no trees, but a "plain green moss" in their place. He was told that the trees had been overturned by the wind, and afterwards covered by the moss, and further that none could pass over it because it would not support a man's weight. The Earl "must needs try it," and fell in up to the arm-pits.

A section through a thick bed of peat will sometimes reveal the manner of its growth. The lower part is often compact, the upper layers of looser texture. It is not uncommon to find by microscopic examination that while the lower part is made up entirely of Sphagnum, the more recent growth is due to heather, crowberry, grasses, hair-moss, and lichens. In some places the whole thickness is of Sphagnum only; in others there is no Sphagnum at all. Peat formed of Sphagnum only has no firm crust, and from the circumstances of its growth it is likely to be particularly wet. Sphagnum often spreads over the surface of pools or even small lakes, not nearly so often in Yorkshire, however, as in a country of well-glaciated crystalline rocks, where lakes abound. In such cases a peculiar kind of peat is formed as a sediment at the bottom of the water, which may in the end fill up the hollow altogether. A very slight cause is enough to start a Sphagnum bog, such as a tree falling across a stream, or a beaver-dam. When a pool forms above the dam, the Sphagnum spreads into it, and the peat begins to grow. Long afterwards, when the hollow is completely filled with peat, there may be a chance for grasses, rushes, crowberry and heather.

In our own time and country the moors waste faster than they form; it is much commoner to find the grass gaining on the heather than to find the heather gaining on the grass. There is no feature of the Yorkshire hills more desolate than ground covered with wasting peat. The surface is cut up by innumerable channels, with peaty mounds between. These are either absolutely bare, or thinly covered with brown grasses and sedges. The dark pools which lie here and there on the flats are overhung by wasting edges of black peat. It is cheerful to step from this dismal territory to ground clothed with close-growing grasses of a lively green, such as we find where the peat has disappeared altogether.

The moors are commonly wet, very wet in places. In certain parts and during certain seasons of the year they are, however, particularly dry, and subject to a severity of drought which the lower slopes and the floor of the valley know nothing of. At lower levels trees give shelter from sun and wind; night-mists check evaporation, and even return a little moisture to the earth; the deep, finely divided soil lodges water, which is given off little by little, and in our climate never fails to yield an effective supply to the roots; pools and streams dole out sparingly the water which fell long before as rain. But the moor lies fully open to sun and wind. In March it is exposed to the east wind; in June to hot sun and cold, clear nights; in August there is perhaps a long spell of drought; in November heavy gales with abundance of rain. The summer is late; the moorland grasses make little growth before the beginning of June; even then the heather bears few young leaves, while the fronds of the bracken are only beginning to push through the soil. Whatever the weather, there is no protection against its extremes; there is no shelter and no shade. The air is cold; wind and the diminished pressure due to height favour rapid evaporation. Though the Sphagnum-patches form permanent bogs, a great part of the moor becomes far drier in a hot summer than any pasture or meadow. The top of the peat crumbles, and is blown about as dust, the loose sand can hold no moisture, bared surfaces of clay become hard as iron. Another feature which must profoundly affect the vegetation of the moor is the poverty of its water in dissolved salts. It is pure and soft, like distilled water, and contains hardly any mineral food for plants. The plants of the moor are subject to the extremes of wet and dry, to cold and to famine.

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[1] In Yorkshire I think that birch and alder are the commonest of the buried trees.

The best-known and most characteristic of the moorland plants are the heaths. Ling, the common heather, is the most abundant of all; it sometimes covers many square miles together to the almost complete exclusion of other plants. Ling is a low shrub, whose wiry stems creep and writhe on the surface of the ground. When sunk in deep peat the stems are often pretty straight, but among rocks you may follow the twisted branches for many yards, and at last discover that what you took for small plants rooted near the surface are really the tops of slender trees, whose roots lie far below. Bilberry too wriggles among loose stones or fallen blocks till you grow weary of following it. The leaves of ling are dry, hard and evergreen. They last for two or three years, and do not fall off as soon as they die, but crumble slowly away. They are very small, densely crowded, and ranged on the branch in four regular rows. A good thin section through a leaf is not easy to cut; when you get one, you find that the interior is largely occupied by irregular air-spaces, and that the stomates are sunk in a deep groove on the under side of the leaf, where they are further sheltered by hairs.

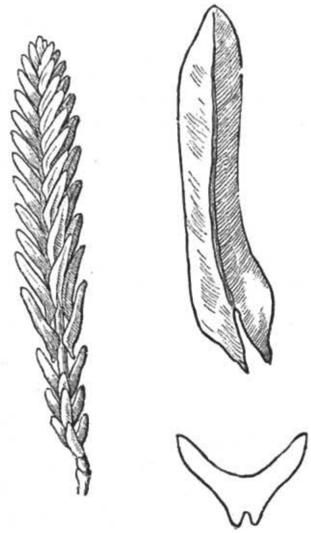

FIG. 3.—Ling (*Calluna vulgaris*). A leafy branch, a single leaf, seen from beneath, and a cross-section of the base of the leaf.

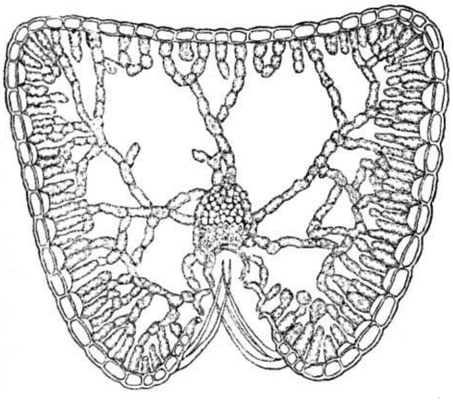

FIG. 4.—Transverse section of leaf of Ling, showing large air-spaces, the reduced lower epidermis which bears the stomates, and the long hairs which help to close the cavity into which the stomates open.

Ling is a plant of slow growth, and a stem which showed seventeen annual rings was only a centimetre in diameter. Stems of greater age than this are rare. After ten or twelve years the plants flower scantily, and exhibit other signs of age. Then the common practice is to burn them off.

As we travel south, we find the ling getting smaller and smaller. In Scotland it is often waist-deep, in Yorkshire knee-deep, on Dartmoor only ankle-deep. On the moors of the south of England the ling is generally much mixed up with grasses, as also on the verges of the Yorkshire moors. In Cornwall it may grow so close to sea-level that it is wet with salt spray in every storm, and its tufts are intermingled with sea-pink and sea-plantain. At the Lizard, wherever the serpentine comes to the surface, ling ceases, and the Cornish heath (*Erica vagans*) takes its place.

Here and there we find among the ling the large-flowered heaths with nodding pink or purple bells (Scotch Heath, Cross-leaved Heath). The leaves of these plants are much larger and thinner than those of ling; they are called "rolled leaves," because the edges curve downwards and inwards, partly concealing the under surface, which bears the stomatês. All our native heaths agree in possessing wiry stems, long roots, and narrow, evergreen leaves, with a glossy cuticle and small transpiring surfaces. The tissues are very dry, and burn readily even when green or drenched with rain. It is possible by good management to set acres of heather in a blaze, even in midwinter, with a single lucifer match. The heaths wither very slowly when gathered, and change little in withering.

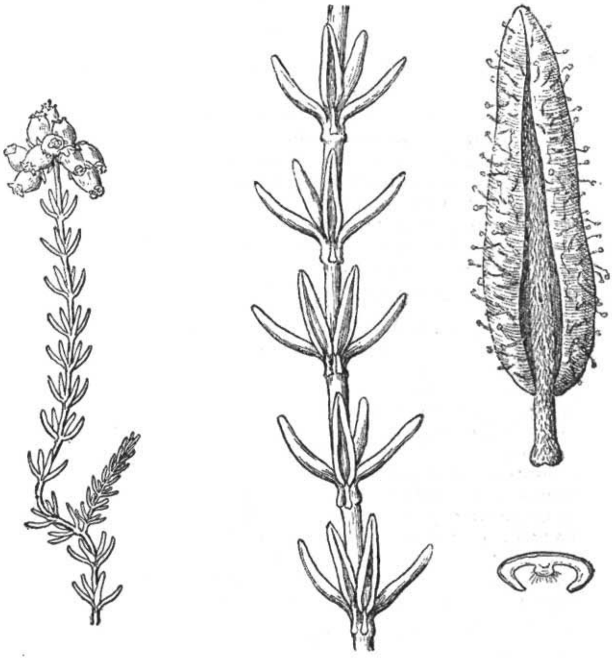

FIG. 5.—Cross-leaved Heath (*Erica tetralix*), with part of a branch, enlarged; a leaf seen from the under side, and a section of a leaf.

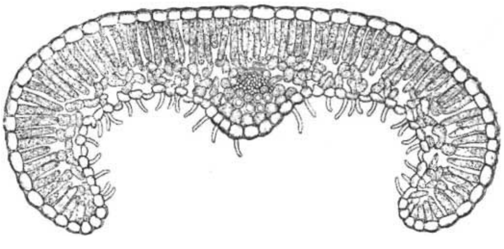

FIG. 6.—Transverse section of rolled leaf of cross-leaved Heath (*Erica tetralix*).

Some of these features are characteristic of desert-plants. Many desert-plants have reduced transpiring surfaces and hidden stomates. They often have very long roots, as was particularly observed in the excavations for the Suez canal.[1] The leaves are often small and crowded, the stems woody, much branched and tufted. Bright sunlight retards growth, and green tissues hardly ever present a large absorbing surface when they are habitually exposed to bright light. Accordingly the young shoots and branches do not push out freely, but try to hide one behind another. The tissues of desert-plants may be remarkably dry; they are often, however, remarkably succulent; the plant either learns to do without water for a long time together, or to store it up.

It is not without surprise that we learn how similar are the effects of tropical drought and of Arctic cold. The facts of distribution would in themselves suffice to show that our moorland heaths are well-fitted to endure great cold. Ling extends far within the Arctic circle, though it seldom covers large surfaces there, and it rises to 2000 metres (6600 feet) on the north side of the Alps It extends southward to the shores of the Mediterranean. Our large-flowered heaths have not been traced quite so far north as ling, and they are not found on the Alps, though they inhabit the Pyrenees. Many representatives of the heath family, with like structure of leaves, are found in the extreme north of the American continent. Those features which assimilate our heaths to desert-plants, and which seem to be obvious adaptations to a situation of extreme drought, are equally serviceable to plants which have to face boisterous winds and low temperature. The shrubs of the far north are low, tufted, small-leaved, evergreen, and dry—just like the heaths of our moors. Middendorff[2] shows how the Dahurian larch becomes stunted in proportion to increasing cold. Before it disappears altogether, it is cut down to a prostrate, creeping shrub. One such dwarf larch, though 150 years old, was only a foot or two across. Plants much exposed to biting winds must make the most of any shelter that can be had; their branches push out timidly, and for a very short distance; the leaf-surface is reduced to a minimum; since the warm season is short, evergreen leaves are profitable, for they enable the plants to take advantage of early and late sunshine.

The heaths and many other moorland plants bear the marks of the *Xerophytes*, or drought-plants. Xerophytes grow under a considerable variety of conditions, some of which do not suggest drought at first sight, but their tissues are always ill-supplied with water. It may be that water is not to be had at all, as in the desert; or that water must not be imbibed in any quantity because of low temperature, as in Arctic and Alpine climates; or that the water is mixed with useless and perhaps injurious salts, from which it can only be separated with great difficulty, as in a salt-marsh. Whatever may be the reason for abstinence, xerophytes absorb water slowly, part with it slowly, and endure drought well.

In the case of moorland plants there is an obvious reason why many of them, though not quite all (Sphagnum is one exception) should rather thirst and grow slowly than pass large quantities of water through their tissues. The water contains hardly any potash or lime, and very little that can aid the growth of a plant. But it is probable that this is not the sole reason. Except where special defences are provided, it is dangerous for a plant which may be exposed to wind or low temperature to absorb much water.

(*To be continued.*)

INDIAN COALS AT THE IMPERIAL INSTITUTE.

THE Imperial Institute has been subjected to much adverse criticism. Its commercial collections, refreshment catering, fellows' club, limelight lectures by eminent men, continental orchestras, library, exhibitions, journal, and commercial intelligence department have all in turn been disparaged. The scientific and technical department has alone escaped attack. There, in well-equipped laboratories, with an enthusiastic staff of experts, valuable research work on new products has been carried on quietly and continuously for some years past. A striking example of the value of the work done is afforded by the exhaustive report just published on the coal supply of India by Prof. Wyndham R. Dunstan. This report embodies the results of the examination of a large number of selected samples from the principal seams. Methodically arranged, well printed, and written in a style that is not too abstruse for the general reader, it is a model of what such a report should be.

The examination was undertaken at the instance of the Government of India. The results are shown in a tabular form, and the chief points in connection with the occurrence, distribution, production and character of Indian coal are summarised. Unlike the English and Welsh coals, the Indian coals are chiefly of Upper Palæozoic and Lower Jurassic age. They are widely distributed, and only a small portion of the known coal area is as yet worked. The increase in coal production in India of late years is very remarkable, and, as the household consumption is inappreciable, practically the whole output is used for steamships, railways, and factories. The output for 1896 was as follows:—

	Tons.
Assam	177,351
Baluchistan	10,572
Bengal	3,037,920
Burma	22,993
Central India	115,386
Central Provinces	141,185
Nizam's dominions	262,681
Madras Punjab	79,925
Total	3,848,013

The results of the examination of the various coals have been plotted in curves, and a table of previous analyses of Indian coal is also given. The coals vary greatly in composition and in quality. Most of them are quite suitable for ordinary purposes, whilst some of the samples from Bengal and Central India are of excellent quality, quite equal to that of many English or Welsh coals. Among the many samples described are two from Hyderabad, which are of fair quality. Neither of the samples, however, gave such good results as those recorded by Mr. Tookey in Mr. J. P. Kirkup's monograph on the Singareni coalfield, published in the *Transactions* of the Federated Institution of Mining Engineers in 1894 (vol. vi. pp. 421-448). This valuable memoir appears to have escaped Prof. Dunstan's notice in drawing up his useful list of works of importance in connection with Indian coal. The Bengal coal is that most largely mined, and a great deal of it is a serviceable steam-coal. Many samples cake well, and contain but little sulphur. The coke made from this coal appears, therefore, to be suitable for iron making. In view of the occurrence of rich deposits of iron and manganese ores in India, this is a matter of great importance, for, owing to difficulties connected with fuel supply, the records of iron manufacture in India have been disastrous. Attempts to manufacture steel in Southern India were made in 1818, in 1830, in 1833 and in 1853, but in each case the want of suitable fuel was an unsurmountable difficulty. Charcoal was exclusively used; and in order to supply one blast-furnace it was necessary to clear no less than two acres of moderately heavy forest per day. For every ton of charcoal made, five tons of wood were consumed. The information contained in Prof. Dunstan's report should therefore show that the difficulties in the way of creating an Indian iron industry presented by the fuel supply can easily be overcome. Indeed, the supply of coal is so enormous that this report should be the means of directing attention to the possibilities of many other branches of industrial enterprise.

BENNETT H. BROUGH.

THE INTERNATIONAL AERONAUTICAL CONFERENCE.[1]

THE second meeting of the International Aeronautical Committee (which was appointed by the Paris Meteorological Conference of 1896) was held at Strassburg, Germany, March 31 to April 4, inclusive. Besides the President, Prof. Hergesell of Strassburg, and the Secretary, M. de Fonvielle of Paris, there were present the following members of the committee: Messrs. Cailletet and Besançon of Paris, Assmann and Berson of Berlin, Erk of Munich, Rykatcheff and Kowanko of

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[1] Examples are quoted by Warming, *Lehrb. d. ökol. Pflanzengeographie*, p. 198.

[2] "Sibirische Reise," vol. iv. p. 605.

[1] By A. Lawrence Rotch. (Reprinted from the U.S. *Monthly Weather Review* for April.)